What is claimed is:

1. A time-of-flight ion mass spectrometer comprising:

an evacuated enclosure;

means for generating an electric field located in said evacuated enclosure;

means for injecting a sample material into said electric field;

a source of continuous ionizing radiation injecting ionizing radiation into said electric field to ionize atoms or molecules of said sample material; and

timing means for determining time elapsed between arrival of a secondary electron having a particular energy out of said ionized atoms or molecules at a first predetermined location and arrival of a sample ion having a particular energy out of said ionized atoms or molecules at a second predetermined location.

2. The time-of-flight ion mass spectrometer as described in Claim 1 wherein said source of continuous ionizing radiation emits electrons.

3. The time-of-flight ion mass spectrometer as described in Claim 1 wherein said source of continuous ionizing radiation emits ions.

4. The time-of-flight ion mass spectrometer as described in Claim 1 wherein said source of continuous ionizing radiation emits photons.

5. The time-of-flight ion mass spectrometer as described in Claim 1

wherein said means for injecting a sample injects a gas sample into said linear electric field.

6. The time-of-flight ion mass spectrometer as described in Claim 1, wherein said means for injecting a sample injects a solid sample into said linear electric field.

7. The time-of-flight ion mass spectrometer as described in Claim 1 wherein said means for determining time elapsed comprises a timing circuit capable of starting timing upon arrival of said secondary electron at said first predetermined location, and stopping timing upon arrival of said sample ion at said second predetermined location.

8. The time-of-flight ion mass spectrometer as described in Claim 7, wherein said timing circuit starts timing upon receipt of a signal from a microchannel plate detector.

9. The time-of-flight ion mass spectrometer as described in Claim 7, wherein said timing circuit starts timing upon receipt of a signal from a channel electron multiplier.

10. The time-of-flight ion mass spectrometer as described in Claim 7, wherein said timing circuit stops timing upon receipt of a signal from a microchannel plate detector.

11. The time-of-flight ion mass spectrometer as described in Claim 7, wherein said timing circuit stops timing upon receipt of a signal from a channel electron multiplier.

12. The time-of-flight ion mass spectrometer as described in Claim 1, further comprising a thin foil sheet over said first predetermined location and over said second predetermined location.

13. The time-of-flight ion mass spectrometer as described in Claim 1, wherein said means for generating a continuous electric field comprises a first voltage, V_1, connected to said first predetermined location, and a second voltage, V_2, connected to said second predetermined location, where $V_2 > V_1$.

14. The time-of-flight ion mass spectrometer as described in Claim 1 wherein said means for generating a continuous electric field comprises a plurality of concentric electrically conductive rings including a first electrically conductive ring connected to said first predetermined location and a last electrically conductive ring connected to said second predetermined location, each adjacent electrically conductive ring being separated by a resistance, with voltage V_1 connected through a first resistance to said first electrically conductive ring and voltage V_2 connected through a second resistance to said last electrically conductive ring, where $V_2 > V_1$.

15. The time-of-flight ion mass spectrometer as described in Claim 14 wherein said continuous electric field varies linearly with distance from said second predetermined location to said first predetermined location and wherein resistance values of said resistance between said conductive rings increase quadratically with distance from second predetermined location.

16. The time-of-flight ion mass spectrometer as described in Claim 1 further comprising energy measurement means located in said evacuated enclosure adjacent to said first predetermined location for measuring said particular energy of said secondary electrons.

17. The time-of-flight ion mass spectrometer as described in Claim 16, wherein said energy measurement means is a pair of electrostatic deflection plates biased to different voltages, V_3 and V_4.

18. The time-of-flight ion mass spectrometer as described in Claim 1 further comprising energy measurement means located in said evacuated enclosure adjacent to said second predetermined location for measuring said particular energy of said sample ions.

19. The time-of-flight ion mass spectrometer as described in Claim 18, wherein said energy measurement means is a pair of electrostatic deflection plates biased to different voltages, V_5 and V_6.

20. The time-of-flight ion mass spectrometer as described in Claim 1, further comprising first energy measurement means located in said evacuated enclosure adjacent to said first predetermined location for measuring said particular energy of said secondary electrons and second energy measurement means located in said evacuated enclosure adjacent to said second predetermined location for measuring said particular energy of said sample ions.

21. The time-of-flight ion mass spectrometer as described in Claim 20, wherein said first energy measurement means and said second energy measurement means are each comprised of a pair of electrostatic deflection plates biased to different voltages, wherein said pair of electrostatic deflection plates of said first energy measurement means are biased to V_3 and V_4, and said pair of electrostatic deflection plates of said second energy measurement means are biased to V_5 and V_6.